INDOOR AIR QUALITY ASSESSMENT

North Shore Community College
Beverly Campus
100 Cummings Center, Suite 121 E
Beverly, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Richard Reney, Facilities Director for North Shore Community College (NSCC), the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the NSCC Beverly Campus located at 100 Cummings Center, Suite 121E, Beverly, Massachusetts. The request was prompted by occupant complaints of eye and respiratory irritation, pneumonia, mold concerns and occasional odors from an adjacent beauty shop. On May 25, 2005, a visit to conduct an indoor air quality assessment was made to the NSCC by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Tim Parziale and Mike Farrell, representatives for Cummings Properties and Dick Passeri and Mr. Reney of NSCC.

The NSCC occupies a suite on the ground floor of the Cummings Center, which is a 2 million square foot building originally constructed in the early 1900s as the headquarters for the United Shoe Machinery Corporation. The building has undergone complete interior renovations and currently houses approximately 340 businesses. The NSCC Beverly Campus occupies an interior suite that has no openable windows.

Methods

MDPH staff conducted air tests for carbon dioxide, temperature and relative humidity with the TSI, Q-Trak, IAQ Monitor, Model 8551. MDPH staff also performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of carpeting was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe.

Results

The NSCC has an employee population of approximately 10-15 and can be visited by up to 150 individuals daily. The tests were taken during normal operations, however due to the intermittent scheduling of classes, a number of the classrooms and labs were unoccupied at the time of the assessment. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) parts of air in two of twenty-four areas surveyed, indicating adequate air exchange in the NSCC occupied area of the building. It is, however, important to note that a number of areas were unoccupied or sparsely populated. Low occupancy can contribute to reduced carbon dioxide levels. Carbon dioxide levels would be expected to be increase with full occupancy. One of the two areas, the fiber optics classroom, had carbon dioxide levels that were over 800 ppm while unoccupied. The classroom had been occupied approximately 10 minutes prior to testing and had approximately 15 occupants, further indicating poor air exchange.

Ventilation is provided by a heating, ventilating and air conditioning (HVAC) system that consists of heat pumps located above ceiling tiles (Picture 1). Outside air is drawn in through air intakes located on the exterior wall of the building (Picture 2); air is conditioned and distributed through ducted ceiling vents (Pictures 3 through 5). Air is filtered and returned to the heat pumps by ducted ceiling-mounted return vents (Picture 6). This system was operating throughout the NSCC occupied area during the assessment. Thermostats that control the HVAC system have fan settings of "on" and "automatic". Thermostats were set to the fan "on" setting which is recommended by the MDPH to provide continuous air circulation (Picture 7).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air for office space (15 cfm for classrooms) or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings ranged from 72° F to 74° F, which were within the MDPH recommended comfort guidelines the day of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measurements in the building ranged from 37 to 41 percent, which were within or close to the lower end of the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Occupants in the adult education center expressed concerns about possible mold growth, primarily in carpeting as a result of flooding that may have occurred several years prior to occupation. In order for building materials to support mold growth, a source of moisture is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Building materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of materials with increased moisture levels can also provide clues concerning the source of water supporting mold growth.

In an effort to ascertain moisture content of carpeting in the adult education center, moisture readings were taken in a number of offices and open areas that would have most likely been impacted by moisture. As indicated, moisture content was measured with a Delmhorst Moisture Detector equipped with a Delmhorst Standard Probe. The Delmhorst probe is equipped with three lights that function as visual aids that indicate moisture level. Readings that activate the green light indicate a sufficiently dry or low moisture level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. No elevated moisture readings were measured during the assessment (Table 1). In addition, a thorough visual examination was conducted, and no visible mold growth or associated evidence of water damage in carpeting (e.g., stains, odors) was observed and/or detected during the assessment.

Several areas had water-damaged ceiling tiles, which can indicate dripping from condensation or leaking from the plumbing system (Picture 8). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (carpeting, ceiling tiles, etc.) be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Several areas contained plants. Plants, soil and drip pans can serve as sources of mold growth, and thus should be properly maintained. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. One plant was observed on paper towels (Picture 9), which can absorb moisture and provide a medium for mold growth. Plants should also be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold.

Water coolers were observed on carpeting in a number of areas (Picture 10). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. In addition, some of the coolers had residue/build-up in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Other Concerns

Several other conditions that can potentially affect indoor air quality were identified. Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. As discussed, occupants reported periodic odors from the adjacent beauty shop, which shares a common wall with the adult education center. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were non-detectable (ND) (Table 1). Indoor TVOC concentrations measured throughout the NSCC Beverly Campus the day of the assessment were also ND.

Although no VOCs were detected the day of the assessment, potential pathways were identified. The common wall between the NSCC and adjacent beauty salon is penetrated by utility holes for pipes, electricity, etc. (Picture 11). The utility holes around pipes examined appeared to be tight; however, the terminus of the pipes in the beauty salon could not be examined. The ceiling plenum in room CL 01 was examined, and a space along the common wall that could serve as a potential pathway for fumes/odors between the beauty salon and NSCC was also observed (Picture 12).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no TVOC levels were detected, materials containing VOCs were in use at the NSCC. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Several areas contain photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992).

Air handling units (AHUs) are normally equipped with filters that strain particulates from airflow. Filters for this system are installed within the return vent frame. The type of filter installed at this NSCC location provide minimum of filtration. Mr. Parziale reported that building management is planning to switch to high-efficiency pleated filters. MDPH staff could not determine whether fresh air intakes were equipped with air filters because of design constraints. If fresh, unfiltered air from the outside is drawn into the AHUs, particulates would likely be distributed into the NSCC space. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates

(Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced through increased resistance, a condition known as pressure drop. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Finally, although no complaints of vehicle exhaust odors were reported in the building, the potential for vehicle exhaust odor entrainment exists. Picture 13 shows the close proximity of the fresh air intakes to the parking lot. Under certain wind/weather conditions, vehicle exhaust can be drawn into or entrained in the air intakes. Entrainment of vehicle exhaust to the building may in turn provide opportunities for exposure to combustion products such as carbon monoxide. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1986).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Contact an HVAC engineering firm to evaluate the HVAC system and increase fresh air supply to NSCC space.
2. Continue to operate the ventilation system continuously during periods of occupancy to maximize air exchange.
3. Examine fresh air supplies for filters. If no filters exist, determine if a means to install filters for fresh air intakes is feasible.
4. Change filters as per manufacturer's instructions or more frequently if needed.

5. Continue with plans to increase the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
6. Consult a ventilation engineer concerning re-balancing of the ventilation systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
8. Clean supply/return vents periodically of accumulated dust.
9. Ensure all utility holes and other potential pathways are properly sealed in both the NSCC and their terminus to reduce/eliminate pollutant paths of migration from the beauty shop.
10. Ensure all roof leaks are repaired, and replace water damaged ceiling tiles. Examine the area above and around water-damaged areas for mold growth. Disinfect areas with an appropriate antimicrobial as needed.
11. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Remove paper towels from beneath plants.

12. Relocate or place tile or rubber matting underneath water coolers in carpeted areas. Clean and disinfect reservoirs as needed to prevent microbial growth.
13. Consider posting signs in parking areas adjacent to the building instructing vehicle operators to shut off engines as soon as possible but in no case more than five minutes as required by Massachusetts General Laws 90:16A.
14. Refer to the resource manual and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These resources are located on the MDPH's website: http://mass.gov/dph/indoor_air.

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Picture 1

Heat Pump above Ceiling Tile System

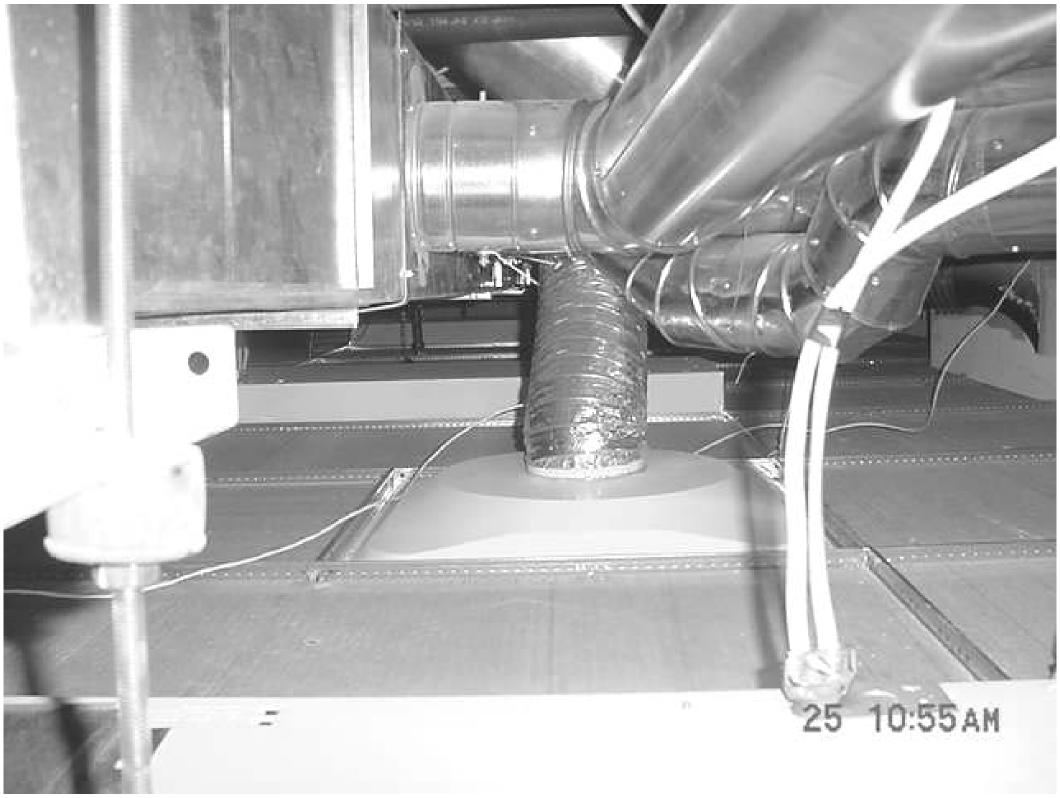
Picture 2

Outside Air Intake

Picture 3

Ceiling-Mounted Multi-Directional Supply Diffuser

Picture 4



Ducted Ceiling-Mounted Air Diffuser (View from Ceiling Plenum)

Picture 5

Ceiling-Mounted Air Diffuser, Note Stains on Wall near Vent

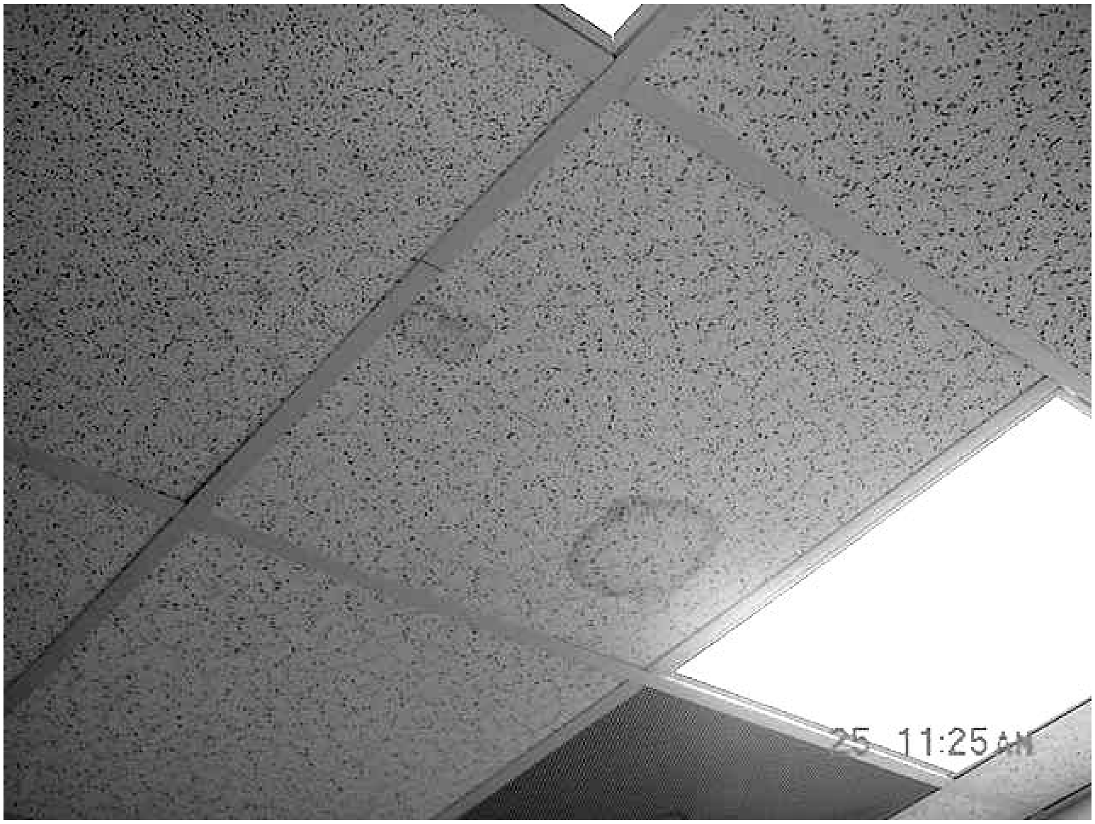
Picture 6

Return Vents Containing Filters

Picture 7

Thermostat for HVAC System

Picture 8

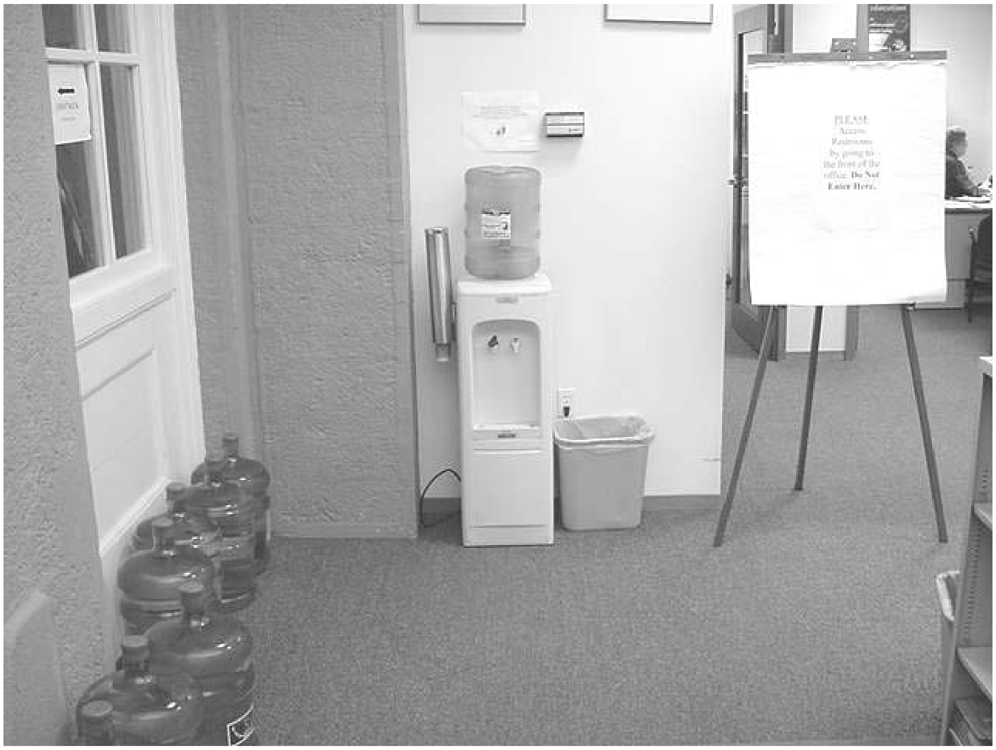


Water Damaged Ceiling Tiles

Picture 9

Plant on Paper Towels

Picture 10



Water Cooler on Carpeting

Picture 11

Pipes through Common Wall in Adult Learning Center, Note Little Space around Pipes

Picture 12

Damaged Ceiling at Junction of Wall Separating NSCC and the Beauty Salon

Picture 13

Proximity of Air Intake to Parked Vehicles

TABLE 1

Indoor Air Test Results – North Shore Community College, Cummings Center, Beverly, MA – May 25, 2005

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Background	341	52	85	ND					Nor'easter conditions, heavy rain NE winds 25-30 gusts up to 50 mph,
Seminar Room	619	72	41	ND	3	N	Y	Y	
Dyke (Office)	703	73	40	ND	0	N	Y	N	DO, carpet moisture-low, plant
Adult Learning Center	687	74	40	ND	0	N	Y	Y	Dry erase markers/board, carpet moisture-low
Rakoc (Office)	765	74	39	ND	1	N	Y	N	Carpet moisture-low
Glenn (Office)	683	74	38	ND	0	N	Y	N	Carpet moisture-low
Storage/Break Room	689	74	37	ND	0	N	Y	N	Carpet moisture-low
Kirpatrick (Office)	692	73	38	ND	0	N	Y	N	
Fiber Optics Classroom	804	73	39	ND	0	N	Y	Y	15 occupants gone 10 min, 4 water damaged ceiling tiles, dry erase board/markers
Computer Server Room	721	74	38	ND	0	N	Y	N	Dry erase board/markers, 3 water damaged ceiling tiles

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results – North Shore Community College, Cummings Center, Beverly, MA – May 25, 2005

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
CL 03 Computer Lab	681	72	38	ND	0	N	Y	Y	Dry erase board/markers
CL 04 Computer Lab	909	72	40	ND	11	N	Y	Y	Dry erase board/markers
CL 02	668	73	38	ND	0	N	Y	Y	Dry erase board/markers
C 05	608	72	38	ND	0	N	Y	Y	Dry erase board/markers
Main Area	651	72	38	ND	5	N	Y	Y	Staff eating lunch
CL 01	553	72	38	ND	0	N	Y	Y	Potential open joint above ceiling tiles, dry erase board/markers
Boyd	674	73	39	ND	1	N	Y	Y	
Main Reception	645	74	38	ND	2	N	Y	Y	
Mc Cloud	659	74	38	ND	0	N	Y	Y	
C 14	671	74	38	ND	0	N	Y	N	Plant on paper towel, door open

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							Supply	Exhaust	
C 13	662	74	38	ND	1	N	Y	N	Door open
C 12	662	74	37	ND	0	N	Y	N	Door open
C 11	689	74	37	ND	0	N	Y	N	Door open
C 10	687	74	38	ND	0	N	Y	N	Door open

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